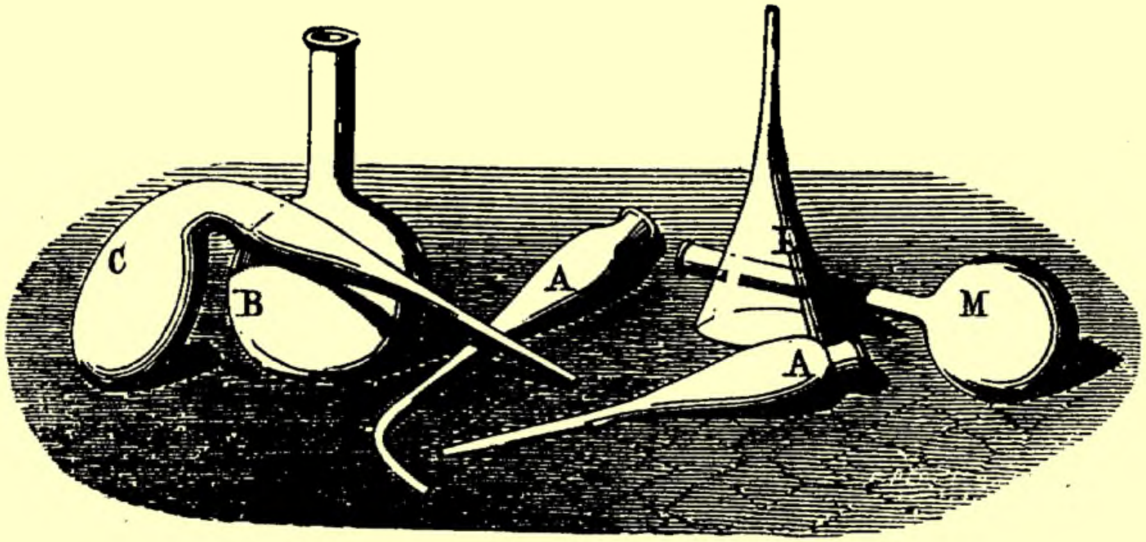
American Chemical Society

DIVISION OF THE HISTORY OF CHEMISTRY



PROGRAM & ABSTRACTS

256th ACS National Meeting
Boston, MA
August 19-23, 2018

Nicolay V. Tsarevsky, Program Chair

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Final Program

DIVISION OF THE HISTORY OF CHEMISTRY (HIST)

N. V. Tsarevsky, *Program Chair*

SUNDAY MORNING

Section A

Seaport Boston Hotel, Constitution

Tutorial & General Papers

N. V. Tsarevsky, *Organizer, Presiding*

8:15 HIST 1. **WITHDRAWN**

8:45 HIST 2. Chemistry in South Korea before and after the Korean War. **C.H. Do**

9:15 HIST 3. **WITHDRAWN**

9:45 HIST 4. William G. Houskeeper and the centenary of the glass-to-metal seal. **R.L. Hudson**

10:15 Intermission.

10:30 HIST 5. Structures from the Werner-Jørgensen controversy: New crystallographic data in the context of the compounds' first syntheses. **D.R. Manke**

11:00 HIST 6. Baeyer-Villiger oxidation: Discovery, discoverers and development. **I. Henrich**, D.E. Lewis

11:30 HIST 7. Rufus Phillips Williams (1851-1911): An exceptional nineteenth century American teacher of chemistry. **W.P. Palmer**

SUNDAY AFTERNOON

Section A

Seaport Boston Hotel, Constitution

HIST Business Meeting: open to all members
1:30 – 2:00

Past ACS Presidents: The Life & Career of Arthur Cope

R. A. Egolf, J. Hayes, *Organizers, Presiding*

2:00 HIST 8. Service legacy of Arthur C. Cope - ACS and beyond. **J. Hayes**

2:30 HIST 9. Arthur C. Cope: His career and life. **R.A. Egolf**

3:00 HIST 10. Continuing the Cope legacy: The Arthur C. Cope Scholar Awards. **J. Hayes**

SUNDAY EVENING

Seaport Boston Hotel, Seaport Ballroom B

5:30 - 7:30 HIST Executive Committee Meeting

MONDAY MORNING

Section A

Seaport Boston Hotel, Constitution

Louis Pasteur's Discovery of Molecular Chirality: Review & Analysis on the 170th Anniversary

J. Gal, *Organizer*
G. S. Girolami, *Organizer, Presiding*

8:25 Introductory Remarks.

8:30 HIST 11. Pasteur: Biographical narrative. **V.V. Mainz**

9:00 HIST 12. Foundations of Pasteur’s discovery of molecular chirality. **G.S. Girolami**

9:30 HIST 13. Why did Pasteur dissolve his crystals? **B.E. Kahr**

10:00 Intermission.

10:15 HIST 14. Louis Pasteur: A philatelic homage. **D. Rabinovich**

10:45 HIST 15. More stereochemical discoveries by Pasteur ahead of organic structural formulas. **A. Greenberg**

11:15 HIST 16. Biological aspects of molecular chirality: Some 19th-century highlights. **C.J. Giunta**

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MONDAY AFTERNOON

Section A

Seaport Boston Hotel, Constitution

Louis Pasteur's Discovery of Molecular Chirality: Review & Analysis on the 170th Anniversary

J. Gal, *Organizer*
G. S. Girolami, *Organizer, Presiding*

1:30 HIST 17. Symmetry-breaking in organic fluids. **D.M. Walba**

2:00 HIST 18. Pasteur and the fine arts. **B. Hansen**

2:30 HIST 19. Pasteur and serendipity in science. **J. Crassous**

3:00 Intermission.

3:15 HIST 20. Path to Pasteur's paratartrate discovery: New insights drawn from his wayward first two laboratory notebooks. **G.S. Girolami**, J. Gal

3:45 HIST 21. Nanoscience and chirality. **T. Bürgi**

4:15 HIST 22. Molecular chirality in chemistry and biomedicine Toda. **C.J. Welch**

MONDAY EVENING

Section A

Boston Convention & Exhibition Center, Exhibit Hall B2/C

Sci-Mix

N. V. Tsarevsky, *Organizer*

8:00 - 10:00

HIST 1 – **HIST 3**, **HIST 6**. See previous listings.

HIST 30. See subsequent listings.

TUESDAY MORNING

Section A

Seaport Boston Hotel, Constitution

HIST Award Symposium Honoring David Lewis

Cosponsored by PROF
S. C. Rasmussen, *Organizer, Presiding*

8:30 Introductory Remarks.

8:45 HIST 23. Early history of polyaniline - revisited: Russian contributions of Fritzsche and Zinin. **S.C. Rasmussen**

9:15 HIST 24. Dehydration, dienes, high octane, and high pressures: Contributions from Vladimir Nikolaevich Ipatieff, a father of catalysis. **C.P. Nicholas**

9:45 HIST 25. Laboratory practices and disciplinary boundaries: The early history of deuterium. **S.J. Weininger**

10:15 Intermission.

10:30 HIST 26. Atomic volumes and Mendeleev's development of the periodic table. **V.V. Mainz**, G.S. Girolami

11:00 HIST 27. Russia in the periodic table. **M.V. Orna**

11:30 HIST 28. Mikhail Vasilyevich Lomonosov (1711-1765): A Russian polymath and chemist. **N.V. Tsarevsky**

TUESDAY AFTERNOON

Section A

Seaport Boston Hotel, Constitution

HIST Award Symposium Honoring David Lewis

Cosponsored by PROF
S. C. Rasmussen, *Organizer, Presiding*

1:30 HIST 29. Christian Hoffmann: Wandering chemist. **I. Rae**, S. Maroske

2:00 HIST 30. Twenty years of classic chemistry on the internet. **C.J. Giunta**

2:30 HIST 31. Aleksandr Butlerov and "chemical structure". **A.J. Rocke**

3:00 Intermission.

3:15 HIST 32. Kazan School of Chemistry: A reinterpretation. **N. Brooks**

3:45 Award Presentation.

4:00 HIST 33. 1859-1860: Magic years in the development of the structural theory of organic chemistry. **D.E. Lewis**

TUESDAY EVENING

HIST Award Banquet honoring Dr. David Lewis

6:30 - 8:30 Banquet at Ristorante Lucia (415 Hanover Street)

WEDNESDAY AFTERNOON

Polymer History

Sponsored by POLY, Cosponsored by HIST, PMSE and SCC‡

ABSTRACTS

HIST 1

WITHDRAWN

HIST 2

Chemistry in South Korea before and after the Korean War

Choon H. Do, *choondo@sunchon.ac.kr. Korean Chemical Industry Specialists Association, Uljin, Gyeong-buk, Korea (the Republic of)*

Education and introduction of modern chemistry and chemical technologies in Korean society were suppressed severely during the Japanese occupation of Korea between 1910 and 1945. However, after the liberation in 1945 and the establishment of South Korean government in 1948, Korean society started to produce chemical scientists and engineers and to set up chemical industries. After the Korean War, chemical scientists and engineers learned and applied western chemical sciences and technologies vigorously to the development of Korean society with assistance of UN and the United States. Some of details of the progress of chemistry in South Korea with the role of international assistance will be discussed.

HIST 3

WITHDRAWN

HIST 4

William G. Houskeeper and the centenary of the glass-to-metal seal

Reggie L. Hudson, *reggie.hudson@nasa.gov. Code 691, NASA Goddard Space Flight Center, Greenbelt, Maryland, United States*

Chemists and others who use high-vacuum systems often must connect copper and glass, two materials with disparate coefficients of thermal expansion. In 1918, William Gibbons Houskeeper (1883-1962) applied for, and later was awarded, a patent for a process to join glass and metal tubing. Houskeeper's method eventually would find its way into applications as diverse as baseball park lighting and the vacuum tubes used for high voltage sources. Closer to chemistry, the Houskeeper seal was used in the laboratory equipment for some of the very first matrix isolation work of Priestley Medalist and former ACS president George Pimentel, and is still being used in the author's investigations of the chemistry of solar-system and interstellar chemistry. This ACS presentation will review Houskeeper's life and his career as an industrial scientist and will describe an important lesson from the author's experience in researching it. -- Dr. Andrea Sella of University

College London is thanked for his assistance with and enthusiasm for the author's interest in Houskeeper.

HIST 5

Structures from the Werner-Jørgensen controversy: New crystallographic data in the context of the compounds' first syntheses

David R. Manke, *dmanke@umassd.edu. Chemistry & Biochemistry, University of Massachusetts Dartmouth, North Dartmouth, Massachusetts, United States*

Amine-coordinated complex ions of transition metals were some of the most important compounds in the early development of coordination chemistry. Though the complexes have been known for more than 100 years, a surprising number of them have not been crystallographically characterized. Our lab has begun to examine the solid state structures of transition metal complex ions with different nitrogen bases coordinated (e.g. pyridine, ethylenediamine). In our studies we have found interesting structures, which when put in a series can be used as excellent examples of established inorganic chemistry theory. In this presentation, the new crystallographic data will be presented and placed into historical context. This will include discussion of the compounds relative to the earliest report of their syntheses stretching back to the 19th century. The chemists involved in the syntheses will be discussed, with an emphasis on Fritz Reitzenstein, and the complexes will be presented in the context of the prevailing theories at the time. Finally, when examined as series, the complexes can be described in a historical theoretical context, including discussions of Crystal Field Theory and the Jahn-Teller distortion.

HIST 6

Baeyer-Villiger oxidation: Discovery, discoverers and development

Isabelle Henrich[1], *henricir0513@uwec.edu, David E. Lewis*[2]*. (1) Chemistry, UW-Eau Claire, Eau Claire, Wisconsin, United States (2) Chemistry Department, UW-Eau Claire, Eau Claire, Wisconsin, United States*

The Baeyer-Villiger oxidation was first disclosed by the future Nobel laureate, Adolf von Baeyer (1835-1917) and his collaborator, Victor Villiger (1868-1934), in 1899. The reaction has been widely used since its discovery because of its predictable regiochemistry and stereochemistry. As a Nobel laureate, there is no dearth of information about von Baeyer; the same cannot be said for Villiger. In this paper, we will discuss both inventors of the reaction, and trace its early development.

HIST 7

Rufus Phillips Williams (1851-1911): An exceptional nineteenth century American teacher of chemistry

***William P. Palmer**, bill_palmer15@hotmail.com. STEM, Curtin University of Technology, Brighton, Victoria, Australia*

Rufus Phillips Williams was born in 1851 at Ashfield, Massachusetts. He attended Dartmouth College in 1867 and in 1870 he graduated with the degree of A. B. He later obtained an A. M. degree from Dartmouth College, which duplicated the degree that he had already earned from Harvard College for special work in science. In 1885, Rufus Williams was appointed as a chemistry teacher at the English High School, Boston, Massachusetts; he held this position until his death. He had a remarkable and distinguished career at the English High School teaching several thousand boys chemistry. He wrote eight books (three chemistry texts and five chemistry laboratory manuals) and numerous articles about teaching chemistry. His books were extremely popular and his chemistry laboratory manuals with those of Ira Remsen were amongst the first laboratory manuals to allow student input by providing experimental detail and incisive questions on the left-hand side page of the book with the student answering the questions on the right-hand page. This format became very popular. It should be pointed out that his books and style were criticised and this study will consider some positive and negative aspects of his writing. Rufus Phillips Williams died at his home in Cambridge, Massachusetts on 23rd August 1911.

HIST 8

Service legacy of Arthur C. Cope - ACS and beyond

***Janan Hayes**, janan.hayes@gmail.com. Project Inclusion, Citrus Heights, California, United States*

In his quiet competent manner, Arthur Cope served ACS on many levels. Of major discussion in this presentation will be his service as ACS President and as Chair of the ACS Board of Directors. After this service, he expanded his impact further in the science area.

HIST 9

Arthur C. Cope: His career and life

***Roger A. Egolf**, rae4@psu.edu. Chemistry, Pennsylvania State University, Allentown, Pennsylvania, United States*

Arthur Clay Cope is best known today for the reactions named after him, the Cope Elimination and the Cope Rearrangement. He is also known for the ACS awards named after him, the Cope Award and the Cope Scholar Awards. This paper will cover the highlights of his life and career including his education at Butler University and the University of Wisconsin, his postdoctoral work at Harvard, his research during World War II on anti-malarial drugs and chemical warfare agents, and his professorial career at Bryn Mawr, Columbia, and MIT.

HIST 10

Continuing the Cope legacy: The Arthur C. Cope Scholar Awards

Janan Hayes, *janan.hayes@gmail.com. Project Inclusion, Citrus Heights, California, United States*

Arthur Cope was responsible for the establishment of the Cope Scholar Awards. This talk will review the history of the awards program. Include will be comments and contributions from former Cope Scholars on the value of this award to their career progress.

HIST 11

Pasteur: Biographical narrative

Vera V. Mainz, *mainz@illinois.edu. School of Chemical Sciences, University of Illinois at Urbana-Champaign, Urbana, Illinois, United States*

Louis Pasteur (1822-1895) made many contributions to science and society, including the discovery of molecular chirality, work that saved the beer, wine, and silk industries of France and other countries, and the development of successful vaccinations for anthrax in sheep and rabies in humans. This talk will focus on his life up to 1847, when he defended two Ph.D. theses before the Faculty of Sciences in Paris: a physics thesis (*A study of the phenomena related to the rotational polarization of liquids. Application of the rotational polarization of liquids to the resolution of several problems in chemistry*) and a chemistry thesis (*Research on the saturation capacity of arsenious acid. Studies on the potassium-, sodium-, and ammonia-arsenites*). A timeline of his later discoveries will be presented as an introduction to the other talks in this symposium.

HIST 12

Foundations of Pasteur’s discovery of molecular chirality

Gregory S. Girolami, *girolami@scs.uiuc.edu. Chemistry, University of Illinois at Urbana-Champaign, Urbana, Illinois, United States*

In 1848, Louis Pasteur announced his discovery of a relationship between crystal form and optical activity in tartrate salts, which led to our modern concept of stereochemistry. This talk will cover three aspects of what was known in 1848 that served as the foundations of his discovery. These aspects are: (1) What was known about the relationship between shape, optical activity, and the chemical formula of crystals? (2) What was known about tartrate and paratartrate salts? (3) Who influenced Pasteur and led him to this research topic? Much of this talk will be based on scholarship conducted in the past by J. D. Bernal, Sy Mauskopf, and others, but in the course of putting this talk together I have made an interesting discovery. The first published observation of hemihedry in tartrate crystals was not made by Wilhelm Gottlieb Hankel in 1841, as has been thought until now, but rather by a British businessman and amateur crystallographer seventeen years earlier in 1824. This clear description of hemihedral tartrate crystals went unnoticed at the time and seems to have escaped the attention of historians ever since.

HIST 13

Why did Pasteur dissolve his crystals?

Bart E. Kahr*, bart.kahr@nyu.edu. Chemistry, New York University, New York, New York, United States*

Most everybody knows - or at least most everybody reading this abstract knows - that in 1848 Louis Pasteur correlated macroscopic chirality, the shapes of enanitomorphous crystals, with microscopic chirality, the action of the individual molecules on circularly polarized light. The latter step required the dissolution of his hard won crystals. Pasteur published several papers in crystallography before his famous discovery that is the typical starting point for accounts of his chemistry. Here is reviewed the state of the science of crystallography in the middle of the 19th C., how Pasteur went about his goniometry before and during his work on the tartrates, and why he had to dissolve his crystals in order to detect circular birefringence, a necessity that is still resonant today.

HIST 14

Louis Pasteur: A philatelic homage

Daniel Rabinovich*, drabinov@uncc.edu. UNC Charlotte Chemistry, Charlotte, North Carolina, United States*

Louis Pasteur, the iconic French chemist and bacteriologist (1822-1895), is widely recognized for his seminal contributions to the understanding of microbial fermentation and the development of the process of pasteurization for foods and drinks. Equally important, he conclusively disproved the theory of spontaneous generation and created the first vaccines for rabies and anthrax. He received many honors and awards during his lifetime, including membership in the *Légion d'honneur* and election to the French Academy of Sciences and the National Academy of Medicine. Not surprisingly, Pasteur's name is also associated today with an impressive number of hospitals, institutes, buildings, and streets. Furthermore, he is among a handful of scientists who have been depicted on postage stamps from dozens of countries, a select cohort that includes the likes of Einstein, Copernicus, Newton, and Marie Curie. This presentation relies on the use of postage stamps and other philatelic materials (souvenir sheets, postmarks, First Day Covers) to highlight various aspects of the life and work of Louis Pasteur, particularly with regards to his contributions to chemistry and crystallography, most significantly the discovery of molecular chirality in 1848.

HIST 15

More stereochemical discoveries by Pasteur ahead of organic structural formulas

***Arthur Greenberg**, art.greenberg@unh.edu. University of New Hampshire, Durham, New Hampshire, United States*

Louis Pasteur's momentous discovery of the enantiomers of sodium ammonium paratartrate in 1848 was published roughly a decade before the tetravalence of carbon was firmly established and structural formulas similar to modern ones were published. His intuition suggested the abstract possibilities of distorted tetrahedra or helical molecular structures. Although the concept of isomers was known as early as 1824 to be the result of different arrangements of the same atoms, specifics were unknown. For example, a textbook representation of isomeric monoterpenes in the 1850s pictured these simply as attractively-symmetric different arrangements of the constituent carbon and hydrogen atoms. As a result there were significant confusions and surprises in understanding chemical relationships among series of synthetically-related organic molecules. An example would be the series: asparagine, aspartic acid, malic acid, tartaric acid, maleic acid and fumaric acid. The first four are capable of enantiomerism while the last two are not. How could optically-active molecules be synthesized from molecules which could never be optically active? This talk will also describe Pasteur's discovery and exploration of *chemical* means for separation of a racemic mixture into enantiomers.

HIST 16

Biological aspects of molecular chirality: Some 19th-century highlights

***Carmen J. Giunta**, giunta@lemoyne.edu. Le Moyne Coll, Syracuse, New York, United States*

Pasteur discovered molecular chirality in the organic realm, that is among molecules of biological origin. In the decades that followed, chirality was found to have a role among the *processes* of life as well as among its molecules. This presentation will treat several such discoveries, many of which are also due to Pasteur. These include the first recognition of enantioselectivity in a biological process, resolution of a mixture of enantiomers by biological means, identification of chirality in therapeutic agents, and recognition of enantioselectivity in biological receptors.

HIST 17

Symmetry-breaking in organic fluids

***David M. Walba**, walba@colorado.edu. Dept of Chemistry and Biochemistry, University of Colorado Boulder, Boulder, Colorado, United States*

Liquid crystals (LCs) are organic materials exhibiting spontaneous symmetry-breaking in the liquid phase, to form optically anisotropic fluids. Chirality has been a key aspect of LC science since its very beginning, with Friedrich Reinitzer’s discovery in the late 1880s that cholesteryl benzoate forms a birefringent liquid phase, now known as the chiral nematic phase, which exhibits a spontaneous helical variation in the molecular orientation. This macroscopic twist represents a chirality phenomenon; a macroscopic manifestation of the molecular chirality. Until the late 1990s, the formation of all known chiral LC phases required enantiomerically enriched molecules. However,

beginning 1997, the discovery of chiral fluid phases formed from achiral or racemic molecules led to the characterization of several variations of spontaneous achiral symmetry breaking (“breaking” of achiral Schoenflies symmetry to become chiral) in fluids. These represent fluid analogs to Pasteur’s seminal discovery of achiral symmetry breaking upon crystallization of sodium ammonium racemate. LCs showing achiral symmetry breaking are most often (perhaps always) of the “bent-core” variety – the classic example being formation of chiral smectic (layered) phases from a class of resorcinol diesters possessing two “mesogenic” wings. In that system, four diastereomeric phases are formed, two d,l pairs, and two “meso” LC phases. Then, in 2009, two variants of “dark conglomerates” were described. In these phases, layering is only short-range, with fluid order giving rise to chiral, optically isotropic phases (dark between polarizer and analyzer) with optical rotatory power for visible light on the order of 0.5°/ µm. Most recently, in 2013 bent-core materials possessing fluid order in three, were proven to exist. In these phases, known as “twist-bend nematic,” packing in the fluid phase favors a spontaneous twist, affording an optically anisotropic conglomerate lacking any layering. These “fluid” examples of conglomerate formation will be discussed.

HIST 18

Pasteur and the fine arts

***Bert Hansen**, bert.hansen@baruch.cuny.edu. History, Baruch College of CUNY, New York, New York, United States*

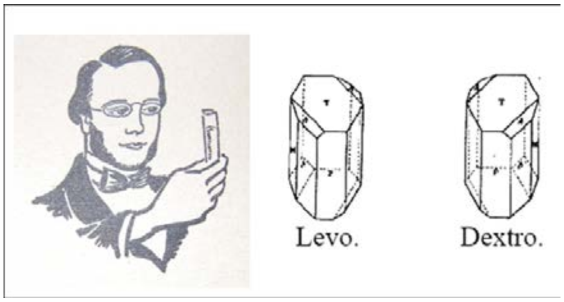
The fine arts played many important roles throughout Louis Pasteur’s life, but his passion for art and his deep friendships with leading artists have been underappreciated by scholars and biographers alike. As my new research has demonstrated, after Pasteur developed his eye and his sensitivity with drawing lessons during his teen years, he was engaged with art (especially drawing, painting, and sculpture) in a variety of ways at all stages of his professional career. Artists became dear friends, and one of them Albert Edelfelt was treated like a member of the family. Pasteur exhibited a strong personal loyalty to artists such as Jean-Jacques Henner, Jean-Joseph Perraud, and Auguste Pointelin, who shared his origins in eastern parts of France. His friends Max Claudet and Paul Dubois, along with his nephew Lucien Laurent-Gsell, created lasting images of this man of science. Pasteur was often accepted by artists as a peer. Additionally, Pasteur used art to shape his reputation. It seems likely that links might be found between Pasteur’s varied engagements with art and his scientific work, but concrete examples remain to be elucidated. During his life, he was honored by gifts from artists; and after his death he was interred beneath the main Pasteur Institute building in a tomb famous for the beauty of its neo-medieval mosaics on the walls and ceiling. The memory and image of Louis Pasteur even today is shaped not only by his major achievements in science and medicine, but by many pieces of art: by painted portraits, news drawings, and cartoons; by the often visited tomb; by the Institute which still houses the paintings and sculptures he collected for it; and by monumental statues in parks around the world.

HIST 19

Pasteur and serendipity in science

***Jeanne Crassous**, jeanne.crassous@univ-rennes1.fr. Institut des Sciences Chimiques, University of Rennes 1, Rennes, France*

The French scientist Louis Pasteur (1822-1895) was undoubtedly a genius of the XIXth century for his decisive achievements in a diversity of domains, from Chemistry to Biology and Medicine, in fundamental and in applied areas, and for his profound thoughts about the foundation of life. Although Pasteur refuted the occurrence of chance and Serendipity in his exceptional scientific discoveries, the question may arise if this is truly the case in several experiments he has performed, especially in the Chemistry domains, where he achieved his first important breakthroughs. The term 'Serendipity' was first utilized by Horace Walpole (1717–1797) in 1754 to define discoveries made unexpectedly or by accident. This term was taken from a Persian fairy tale «The Three Princes of Serendip ». In this presentation, I will discuss some of the occasions where Serendipity may have had an influence on the scientific career of Louis Pasteur, for example during his famous experiment of spontaneous resolution of hemihedral sodium and ammonium tartrates resulting in his discovery of "molecular dissymmetry", or on the occasion of the first enzymatic resolution he achieved. But Pasteur declared, in December 7th 1854, during a famous talk in Douai, "...*le hasard ne favorise que les esprits préparés"* ("*chance only favors prepared minds*"). For sure, Pasteur had a very well prepared mind! He was a very talented artistic drawer, he had a keen sense of observation, he had a perfect knowledge and understanding of contemporary discoveries from other famous scientists that guided his own experiments, he was a very hard worker and a very bright person, ... In summary, one cannot be a Louis Pasteur by chance!



HIST 20

Path to Pasteur's paratartrate discovery: New insights drawn from his wayward first two laboratory notebooks

***Gregory S. Girolami**[2], girolami@scs.uiuc.edu, Joseph Gal[1]. (1) Clinical Laboratory, University of Colorado Hospital, Aurora, Colorado, United States (2) Chemistry, University of Illinois at Urbana Champaign, Urbana, Illinois, United States*

This talk will focus on two topics: (1) the surprising history of Pasteur's first two laboratory notebooks, which cover his earliest scientific work from 1847 through late 1848, and (2) our efforts to construct – for the first time – a full transcription of the initial handwritten draft of Pasteur's 1848 paper announcing his discovery of the connection between optical activity and crystal form. Much of this handwritten draft – which appears in these notebooks – has never been deciphered previously. The draft contains much text that was omitted from the final version, and as a result it provides key insights into the route by which Pasteur was led to his discovery and how he initially interpreted his results. Some of the findings are surprising, and reveal that Pasteur's path from discovery to initial publication involved many twists and false starts, as well as conscious decisions about whether to mention of some relevant work by others.

HIST 21

Nanoscience and chirality

Thomas Bürgi, *thomas.buergi@unige.ch. Department of Physical Chemistry, University of Geneva, Geneva, Switzerland*

Chirality at the nanoscale has gained considerable interest in recent years. The preparation of chiral nanomaterials and the properties they can have is important in pharmaceutical sciences, chemistry, physics and materials science. In this contribution we will first provide some examples of chiral nanomaterials from different fields. We will then focus on a special class of materials: Thiolate-protected gold nanoparticles and clusters. These have promising potential applications as building blocks for nanotechnology, as catalysts or as sensors. Chiroptical studies indicate that chirality can be bestowed to gold clusters through the adsorption of chiral thiolates. However, even with achiral ligands chiral clusters can be obtained. In this case a racemic mixture is obtained during the synthesis. The structure of numerous thiolate-protected gold clusters has been determined by X-ray crystallography. It emerges that a large fraction of these structures are chiral. This chirality can arise at different levels including the core of the cluster, the arrangement of the ligands on the cluster surface and the ligand itself. The separation of enantiomers of chiral clusters is possible using chiral chromatography. Furthermore, chirality at one level can be transferred to another level. For example, vibrational circular dichroism (VCD) reveals that a cluster that is chiral due to the arrangement of the staples on its surface can transfer its chirality to the adsorbed (achiral) ligands. The latter property of the cluster may be of interest for applications in chiral technology.

HIST 22

Molecular chirality in chemistry and biomedicine Toda

Christopher J. Welch, *whelko@comcast.net. Merck Co., Inc., Rahway, New Jersey, United States*

Molecular chirality plays an increasingly important role in modern chemistry and medicine. An overview of historical developments relating to this field will be presented, from Pasteur's19th century discoveries, the early 20th century emergence of molecular medicines, the late 20th century focus on the preparation of enantiopure pharmaceuticals to modern 21st century challenges in relating to molecular chirality and stereochemistry.

HIST 23

Early history of polyaniline - revisited: Russian contributions of Fritzsche and Zinin

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Although the history of polyaniline has been traced back to the 1834 contributions of F. F. Runge in Germany, Carl Fritzsche independently discovered an organic base via the decomposition of indigo in 1840. Fritzsche named the base *anilin* after the Spanish name of indigo, a name which has been retained into the present. Following his isolation of aniline, Fritzsche went on to study its oxidation products, the results of which are consistent with our modern understanding of polyaniline species. Two years after Fritzsche's isolation of aniline, Nikolay Zinin reduced nitrobenzene to give a species that he called *benzidam*, which was confirmed to be aniline by August Hofmann the following year. An overview of Fritzsche and Zinin's work on aniline will be presented, with a focus on aniline oxidation products and potential contributions to polyaniline and its formation.

HIST 24

Dehydration, dienes, high octane, and high pressures: Contributions from Vladimir Nikolaevich Ipatieff, a father of catalysis

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Born in Moscow on November 21, 1867, Vladimir Ipatieff studied math and science at military academies before starting his academic career as an instructor at the Mikhail Artillery Academy in St. Petersberg. Ipatieff finished a dissertation in 1895 under A.E. Favorskii at St. Petersberg University on reactions of bromine with tertiary alcohols. The following year, he was sent abroad to study terpene derivatives, in Munich, Germany with Adolf van Bayer. Before returning to St. Petersberg in 1897 as Professor in the Artillery Academy, Ipatieff spent time in other locations in Germany and France, forging connections with other chemists. Around about 1900, Ipatieff had begun to understand catalytic phenomena such as the dehydrogenation of alcohols to aldehydes and ketones, a class of reactions he called contact reactions at the time due to the interaction of the organic molecules with the steel walls of the reactor. One of his first discoveries was the catalytic dehydration of alcohols to alkenes using Al_2O_3 as a catalyst. By 1928, Ipatieff had risen considerably with promotions to lieutenant general and as director of the Central Chemistry Laboratories, however, political problems loomed and he and his wife Barbara left for Germany in 1930, never again returning to the USSR. While in Germany that year, he met Gustav Egloff of Universal Oil Products (UOP) who, along with Hiram Halle, convinced Ipatieff to come to Chicago part-time as the Director of Chemical Research. By 1931, with the help of Northwestern University, where he was named lecturer, and later Professor, the Ipatieff's were living permanently in Chicago. Ipatieff enjoyed twenty years of success in Chicago, building catalysis research at both UOP and Northwestern, including discoveries such as solid phosphoric acid (SPA), a heterogeneous catalyst still used today for acid catalyzed reactions such as olefin oligomerization. The talk will focus on Ipatieff's life and achievements, including the establishment of the Ipatieff Prize, given by the ACS every third year since 1947 to a researcher under the age of 40 for achievements in catalysis.

HIST 25

Laboratory practices and disciplinary boundaries: The early history of deuterium

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Specific laboratory practices and techniques have become associated with particular disciplines through historically contingent processes. These practices and techniques differ with respect to their ability to detect, measure, and respond to specific objects of investigation. Harold Urey's discovery of deuterium in 1931 and its manifold subsequent outcomes illustrate how these factors played out in one very significant case. Establishing the existence of deuterium required practices characteristic of physics: low-temperature fractionation of liquid hydrogen; measurement of atomic spectra; and calculation of differences between the atomic spectra of hydrogen and deuterium. For chemists, who were mainly interested in using deuterated water, the tried and true methods of determining density and refractive index served to give accurate measures of the quantity of deuterium present. The use of deuterium as a marker in studies of intermediary metabolism, however, necessitated the creative commingling of practices drawn from several disciplines to respond adequately to the complex demands of those investigations.

HIST 26

Atomic volumes and Mendeleev's development of the periodic table

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In August 1869, only five months after his announcement of his periodic law, Dmitri Mendeleev (1834-1907) gave a paper entitled "On the Atomic Volumes of Simple Bodies" at the Second Congress of Russian Scientists, held that year in Moscow. The proceedings of the Congress, which were published early in 1870, contain Mendeleev's 10 page paper along with contributions from other Russian scientists, including the chemists Beilstein, Zaitsev, and Butlerov. Mendeleev's paper on atomic volumes is the second that he wrote on his periodic law, and as such it gives valuable insights into his early thinking. Its Russian text, which has never been translated into any Western language, has remained largely unexamined since it was printed. Atomic volumes (and the related concept of molar volumes) are easily calculated by dividing the atomic or molecular weight (g/mol) of a substance by the density (g/cm^3) of a solid sample of the substance; they therefore have units of cubic centimeters per mole. Shortly after the concept of atomic volume was defined by Le Royer and Dumas in 1821, Polydore Boullay and Amedeo Avogadro noticed that atomic volumes were correlated with certain aspects of chemical reactivity such as cohesive ability and electronegativity. Atomic and molar volumes also formed an important role in Mendeleev's own chemical education: his master's thesis of 1856, which was exclusively devoted to the topic, showed that molar volumes exhibited consistent mathematical regularities. He pointed out, for example, that the molar volume of potassium hydroxide (KOH) is approximately equal to the average of the molar volumes of potassium oxide (K2O) and water (H2O). Moreover, the tables in his master's thesis often list the elements according to what eventually would be groups in the periodic table: the alkali metals Li, Na, K are immediately followed by the alkaline earths Be, Mg, Ca, Sr, Ba; and sulfur and selenium are listed one after the other. Of course atomic volumes were crucial to Lothar Meyer's own independent development of the periodic law. The present talk will describe Mendeleev's 1869 paper on atomic volumes, and his discussion about how their mathematical regularities supported his newly devised periodic law.

HIST 27

Russia in the periodic table

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As every chemist knows, Russia not only had a hand, as a country, in developing the periodic table, but may be hailed as its originator through the persistent and insightful work of Dmitri Mendeleev. It is only right and just that element 101 bears his name. However, there are six other elements that have Russian roots beginning with ruthenium, discovered in 1844 by Karl Karlovich Klaus, and followed by samarium, dubnium, flerovium, moscovium, and oganesson. The discovery of each of these elements is uniquely quirky. It is hoped that these tales will delight, and perhaps even enlighten, the Russophiles among us. This paper is dedicated to David E. Lewis, First Russophile, on the occasion of his reception of the 2018 Award in the History of Chemistry.

HIST 28

Mikhail Vasilyevich Lomonosov (1711-1765): A Russian polymath and chemist

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Mikhail (born Mikhaylo) Vasilyevich Lomonosov (1711-1765) was a major figure of the Russian Enlightenment – a scientist, writer, and poet who made important contributions to fields as diverse as physics, astronomy, metallurgy, mineralogy, chemistry, geology, instrument-making, history, and philology. He was instrumental, with the help of his patron, Ivan Ivanovich Shuvalov (1727-1797), in the establishment of a University in Moscow (now named after him) in 1755. Lomonosov's life as a student and scholar began in 1731 when he was admitted to the Slavo-Greco-Latin Academy in Moscow. Because of his outstanding performance, he was sent to the St. Petersburg Academy to continue his studies. The Academy was staffed exclusively by foreign scholars, none of which was trained in chemistry – a discipline that was much needed in Russia at the time. Since a suitable scientist could not be recruited from Germany to teach chemistry in St. Petersburg, three students from the Academy, among them Lomonosov, were sent to Marburg to study science and philosophy with Christian Wolff (1679-1754) and eventually – to Freiberg to learn chemistry under the German chemist and metallurgist Johann Friedrich Henkel (1678-1744). Upon his return to Russia, Lomonosov began his systematic studies in various branches of natural philosophy, making the very significant discovery (among many others) of the law of preservation of mass in chemical reactions. He also had a very practical mind and became involved in the preparation of pigments and colored glass, which inspired further interest in making mosaic pictures. This talk will describe the main milestones of Lomonosov's career as a chemist.

HIST 29

Christian Hoffmann: Wandering chemist

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George Christian Hoffmann (1837-1917) was a chemist who followed the Crimson Thread of Empire. Born in England but of German extraction, he graduated from the Royal College of Chemistry in the 1850s with special training in analytical chemistry. Thereafter he plied his trade in British colonies - Natal (southern Africa) and Melbourne (Victoria) - before finding a home in the Geological Survey of newly-confederated Canada, where he served for over 40 years. Such a career path was not uncommon for British chemists in the 19th century - educated in the old country, jobs in the new countries. In the 20th century Australian chemists went to old countries for graduate or postgraduate work, but most returned home to make their careers. There were exceptions, of course, like the chemist we honour at this symposium, David Lewis.

HIST 30

Twenty years of classic chemistry on the internet

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The Classic Chemistry website has been an internet resource on history of chemistry for chemists and educators since 1996. It was intended to be a freely available sourcebook of primary literature of important chemical discoveries of the past, a place where chemistry teachers could find, for example, what Dalton actually wrote about atoms. It grew to include a calendar of chemical birthdays and anniversaries, a set of quantitative exercises based on historical chemical data, and a list of links to other sites in history of chemistry. The presentation will include reflections on changes in the availability of classic chemistry texts in the late 1990s compared to the present.

HIST 31

Aleksandr Butlerov and "chemical structure"

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Aleksandr Mikhailovich Butlerov (1828-1886), professor at the Universities of Kazan and St. Petersburg, was a leading organic chemist during the last thirty years of his life. In 1861 he gave an important presentation at the annual meeting of the Society of German Scientists and Physicians in Speyer, entitled "On the Chemical Structure of Compounds." Over the next few years he proved to be one of the most productive and imaginative chemists in Europe, publishing many early landmark syntheses and structure determinations. It is to Butlerov that we owe the word "structure" in a chemical context (Russian "stroenie", German "Struktur"). Russian chemists and historians have always looked to Butlerov as the founder of the theory of chemical structure, in contrast to most Western chemists and historians who give pride of place to August Kekulé, Archibald Couper, and others. Indeed, Butlerov's ideas on the internal constitution of organic

molecules were not identical to those of Kekulé, but we will see that the differences between them had more to do with scientific style and personality than with substantive chemical distinctions.

HIST 32

Kazan School of Chemistry: A reinterpretation

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For a considerable portion of the nineteenth century, chemistry teaching and research at the small and geographically isolated Kazan University outshone that in all other Russian institutions. Chemists working at Kazan University discovered the element ruthenium, discovered the reduction of nitrobenzene to aniline (which would become essential to the synthetic dye industry), firmly established and delineated the structural theory of organic chemistry, developed important synthetic methods using organozinc reagents, and many other important advances in chemistry. As early as the 1860s, some observers began speaking of a “Kazan School of Chemistry.” The classic expression of this view was stated by A. E. Arbuzov, himself a Kazan chemist, in various articles published in the 1930s and after. In Arbuzov’s formulation, the Kazan School of Chemistry began with N. N. Zinin (sometimes including K. Klaus) in the 1830s and continuing in an apostolic succession until the present day. However, as I will argue in this paper, this formulation can work only if the term “school” is rather loosely applied. If we employ a more rigorous definition of school, such as those described by Morrell and Geison, then the Kazan School of Chemistry only began around 1860 with A. M. Butlerov.

HIST 33

1859-1860: Magic years in the development of the structural theory of organic chemistry

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In 1858, Kekulé and Couper independently published their versions of a Structural Theory of Organic Chemistry. At this time, the Russian chemist, Aleksandr Mikhailovich Butlerov (1828-1886) was on *komandirovka* (study leave) in the Wurtz' laboratory in Paris, and during that year he interacted with both Couper and Kekulé. At the beginning of 1859, Butlerov was firmly in the camp of Kekulé, and he wrote a criticism of Couper's version of the theory in which he made the point that he could not support this theory because Couper had extrapolated too far from the experimental data. Within a year, Butlerov had made a complete about-face, and was now the new lead protagonist of Couper's views.Recently, we have obtained copies of the lecture notes taken by a young Markovnikov in the organic chemistry course delivered by Butlerov during the 1859-1860 academic year. At the beginning of this year, Butlerov was a strong protagonist of the more conservative views of Kolbe, and he supported the use of Kolbe's equivalent weights. At its end, he had changed his allegiance, and now strongly supported the new atomic weights of Cannizzarro. This, in turn, was reflected in his version of Structural Theory. I will address the progress in the translation of the Markovnikov notes, and the light they shed on Butlerov's change of stance.